BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an impedance spectrum for painted aluminum following immersion for different periods of salt water exposure.

Fig. 2 is a diagrammatic representation of the sensing device with attached metal tip 2, that serves as the counter and reference electrode. The cable which is attached to 2, is connected to the potentiostat 4. The working electrode 1, is the coated metal being tested and connected to the potentiostat 4, with an attached wire 3.

Fig. 3 is a graphic representation of impedance spectra of epoxy-polyimide painted aluminum with and without a scratched defect using both a conventional three-electrode measurement and measurements made using three different embodiments of the present invention.

Fig. 4 is a graphic representation of vinyl-coated steel panels exposed to ambient fresh water obtained using the present invention.

Fig. 5 is impedance spectra for a painted aluminum specimen with a scratch to simulate a coating defect.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The invention provides a portable, hand-held, in-situ electrochemical sensor capable of detecting and monitoring corrosion of an actual structure from the earliest stages of deterioration. The sensor utilizes electrochemical impedance spectroscopy (EIS) for investigating corrosion and coating degradation.

Referring to the drawings, Fig. 1 is a plot of an impedance spectrum for painted aluminum following immersion for different periods of salt water exposure. The figure shows that initially the coated metal demonstrates capacitive behavior with very high impedance at low frequencies. As the coating degrades during immersion, its resistance decreases and the impedance become independent of frequency at low frequencies.

Fig. 2 is a drawing of a portable hand-held in-situ sensor with a metal tip 2, which acts as a reference and counter electrode. 2 is encased in a nonconductive plastic shield in the form of a pen-like holder for easy grasping in order to hold the tip of the electrode 2 onto the working painted metal 1 that is being tested. A cable is attached to the top of the pen-like electrode 2, to facilitate an easy electrical connection to a potentiostat 4. The working electrode 1, has a cable attached 3, for electrical connection to the potentiostat 4.

Fig. 3 is a series of impedance spectra of epoxy-polyamide panted aluminum with and without a scratch defect. Each of the three variation of the hand-held probe gives results very similar to the conventional three-electrode measurements. Each measurement very clearly reflects the presence of a gross defect such as a scratch.

Fig. 4 is a series of impedance spectra of vinyl-coated steel panels exposed to ambient fresh water for excellent condition even after 22 years of exposure; others were severely deteriorated even after one year. The correlation using the portable, hand-held in-situ electrochemical sensor is excellent. The coatings that appeared in excellent condition exhibited very high impedance with predominately capacitive behavior. In contrast, those coatings that were in poor condition with numerous blisters or rusty areas had very low impedance and mostly resistive behavior.

Fig. 5 is a series of impedance spectra for a painted aluminum specimen with a scratch to simulate a coating defect. As the portable, hand-held, in-situ sensor was moved further from the defect, a plateau region at intermediate frequencies appears and corresponds to a conduction path along the surface.